
DEPARTMENT OF THE ARMY 02225.TD
CORPS OF ENGINEERS, TULSA DISTRICT JAN 97

TULSA DISTRICT GUIDE SPECIFICATION

SECTION 02225

EARTHWORK FOR ROADWAYS, RAILROADS, AND AIRFIELDS
07/89

NOTE: This guide specification covers the requirements for excavation, embankment, and preparation of subgrades for roadways, railroads, and airfields. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

1 GENERAL

NOTE: See Additional Note A.

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1140	(1992) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve

ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 4253	(1993) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4643	(1993) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

1.2 DEFINITIONS

NOTE: This guide specification includes all excavating, grading, and associated operations that may be required under a contract covering grading for roads, streets, railroads, airfields, and/or parking and storage areas. There are certain operations and items of construction that may be omitted as not being applicable to the particular work under consideration, or may, for certain reasons, be performed as independent operations or as subsidiary operations under other contracts. Any portions of the provisions of this specification covering the various work items that, in the opinion of the Contracting Officer, are not applicable to the work under consideration or can be more expeditiously or advantageously performed under other contracts will be deleted. This specification and/or any other specification affected will be revised to fit local conditions.

1.2.1 Satisfactory Materials

NOTE: Satisfactory material will be defined in accordance with locally available materials, design slopes, etc., and all suitable classes will be listed in the project specification in accordance with the Unified Soil Classification System, ASTM D 2487.

Materials classified in **ASTM D 2487** as GW, GP, and SW, GC, GM, SP, SM, SC, and CL and shall be free from roots and other organic matter, trash, debris, and frozen materials and stones larger than **150 mm 6 inches** in any dimension are satisfactory.

1.2.2 Unsatisfactory Materials

NOTE: Unsatisfactory material will be defined in accordance with locally available materials, design slopes, etc., and all unsuitable classes will be listed in the project specification in accordance with the Unified Soil Classification System, ASTM D 2487.

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Materials classified in **ASTM D 2487** as Pt, OH, OL, ML, MH, AND CH and any other materials not defined as satisfactory.

1.2.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in **ASTM D 2487** as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

1.2.4 Degree of Compaction

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in **ASTM D 1557** or **ASTM D 4253**. **ASTM D 1557** shall be used for soils containing 15 percent or more passing the no. 200 sieve (fines). **ASTM D 4253** shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the no. 200 sieve shall be determined in accordance with **ASTM D 4253**. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density.

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an

item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-08 Statements

Earthwork; FIO.

Procedure and location for disposal of unused satisfactory material. Blasting plan when blasting is permitted. Proposed source of borrow material.

SD-09 Reports

Testing; FIO.

Within 24 hours of conclusion of physical tests, Y copies of test results, including calibration curves and results of calibration tests.

SD-13 Certificates

Testing; FIO.

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

SD-18 Records

Earthwork; FIO.

Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.4 CLASSIFICATION OF EXCAVATION

NOTE: Inapplicable portions will be deleted. Other classifications of excavation may be utilized as required.

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.4.1 Rock Excavation

Rock excavation shall include blasting, excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposition of boulders 1/2 cubic meter yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; and conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock that is impossible to remove without systematic drilling and blasting. The removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic meter yard in volume that may be encountered in the work shall be included in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, such material shall be uncovered and the Contracting Officer notified by the Contractor. The Contractor shall not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.4.2 Common Excavation

Common excavation shall include the satisfactory removal and deposition of all materials not classified as rock excavation.

1.5 BLASTING

Blasting will not be permitted.

1.6 UTILIZATION OF EXCAVATED MATERIALS

NOTE: Specification provisions covering excavated materials authorized to be wasted will usually include the provision that the surface and side slopes formed from such material be shaped and sloped so as to provide for drainage and for late seeding and mowing operations. It is not contemplated that hand placing of coarse rock from excavation will be required except for unusual cases of embankments or channel protection. Where hand placing of the coarse rock is necessary, this provision will be stated definitely in the specification, the brackets will be removed, and the approximate amounts and locations of the hand placing of coarse rock will be indicated on the drawings. Where hand placing is not required, the inapplicable expression and all brackets will be deleted.

All unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. Newly designated waste areas on Government-controlled land shall be cleared and grubbed before disposal of waste material thereon. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of in such a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

2 PRODUCTS (NOT APPLICABLE)

3 EXECUTION

3.1 STRIPPING OF TOPSOIL

NOTE: Topsoil will be separately excavated, stored, and used for surface finish in preparation for seeding, sodding, or other planting, only where topsoil is definitely superior for grass and plant growth as compared with the remainder of the excavated material. Surface soil that is a heavy clay, predominantly sandy, or is lean in grass- and plant-growth qualities, will not be saved. The hauling, spreading, smoothing, and maintenance of the topsoil in preparation for the seeding and planting operations are generally considered under a separate section, and therefore are not considered in this specification. The blank will be filled with the appropriate number of inches.

Where indicated or directed, topsoil shall be stripped to a depth of 150 mm 6 inches. Topsoil shall be spread on areas already graded and prepared for topsoil, or when so specified topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm 2 inches in diameter, and other materials that would interfere with planting and maintenance operations.

3.2 EXCAVATION

The Contractor shall perform excavation of every type of material encountered within the limits of the project, to the lines, grades, and elevations indicated and as specified herein. Grading shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported

to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. [Payment therefor will be made in accordance with the Changes Clause of the CONTRACT CLAUSES.] [Payment therefor shall be included in the Bidding Schedule item for "Excavation".] Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified herein.

3.2.1 Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Care shall be taken not to excavate ditches and gutters below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory thoroughly compacted material or with suitable stone or cobble to grades shown at no additional cost to the Government. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 1 meter 4 feet from the edge of a ditch. The Contractor shall maintain all excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage Structures

NOTE: The sentences in brackets will be removed in all cases except where pile foundations are to be used. If pile foundations are used on a specific job, the brackets will be removed and the sentences will become a part of the specification.

Excavations shall be made accurately to the lines, grades, and elevations shown or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed. [Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation 300 mm 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.]

3.3 SELECTION OF BORROW MATERIAL

NOTE: Where a substantial quantity of borrow excavation is anticipated, the plans and specifications will, where practicable, indicate the location or locations within the project site, and the conditions under which borrow may be obtained.

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas shown or from other approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay all royalties and other charges involved, and bear all expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation and shall be performed by the Contractor at no additional cost to the Government.

3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

NOTE: The sentence in brackets will be deleted when all work covered by Invitation for Bids is to be included in one lump-sum contract price.

[The Contractor shall notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken.] Except as otherwise permitted, borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 GRADING AREAS

When so provided and where indicated, work under contract will be divided into grading areas, within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. The Contractor shall not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing.

3.6 BACKFILL

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, in such a manner as to prevent wedging action or eccentric loading upon or against any structure. Ground surface on which backfill is to be placed shall be prepared as specified in paragraph PREPARATION OF GROUND SURFACE FOR EMBANKMENTS. Compaction requirements for backfill materials shall also conform to the applicable portions of paragraphs PREPARATION OF GROUND SURFACE FOR EMBANKMENTS, EMBANKMENTS, and SUBGRADE PREPARATION, below and Section 02720 STORM-DRAINAGE SYSTEM; and Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the material being compacted.

3.7 PREPARATION OF GROUND SURFACE FOR EMBANKMENTS

3.7.1 Preparation

Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; plowed, disked, or otherwise broken up; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the material being compacted. The prepared ground surface shall be scarified and moistened or aerated as required just prior to placement of embankment materials to assure adequate bond between embankment material and the prepared ground surface.

3.7.2 Proof Rolling

Subgrade areas shall be proof rolled prior to placement of embankment material thereon. Proof rolling shall be in addition to the compaction specified above and shall consist of the application of 6 coverages with a heavy pneumatic-tired roller having four or more tires, each loaded to a minimum of 20 metric tons 20 tons and inflated to a minimum of 6300 grams per square cm 90 psi. Water content of the subgrade shall be maintained at optimum or at percentage directed from start of compaction to completion of proof rolling. Materials underlying materials that produce unsatisfactory results by rolling shall be removed and replaced with satisfactory materials and recompacted.

3.8 EMBANKMENTS

3.8.1 Earth Embankments

NOTE: Moisture content limits for compaction should be included in these paragraphs when considered necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when in the opinion of the project

geotechnical engineer, moisture control is required for the soils being used.

Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm 3 inches. The material shall be placed in successive horizontal layers of loose material not more than 200 mm 8 inches in depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary and scarified or otherwise broken up in such a manner that the fill will bond with the surface on which it is placed. After spreading, each layer shall be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density when ASTM D 1557 procedure is applicable or 95 percent laboratory maximum density when ASTM D 4253 procedure is applicable. Compaction Laboratory maximum density shall be determined in accordance with requirements in Part 1 above. The in-place moisture content of cohesive soils shall range from -1 percent to +2 percent of optimum. No tolerance will be permitted outside this range. requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in paragraph SUBGRADE PREPARATION. Compaction shall be accomplished by sheepfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the type of material being compacted.

3.8.2 Rock Embankments

NOTE: The design engineer will determine the appropriate values for all blank spaces except the last one in this paragraph on the basis of recent experience on similar construction or of test results obtained from construction and testing of a test section. The specific method by which density will be determined in the laboratory and measured in the field will be described in the project specification. The total thickness of the pavement structure, including select material subbase, base, and pavement, in inches, will be placed in the last blank space in this paragraph. The inapplicable expression in brackets and all brackets will be deleted. The first expression in brackets applies to rock fill of small maximum dimension and maximum lift placement of 8 to 10 inches. If it is necessary to use larger rock and thicker lifts, the second expression in brackets is applicable. When thicker lifts are used it may be necessary to specify a minimum number of passes of the compactor.

Rock embankments shall be constructed from material essentially classified as rock excavation, as defined above, placed in successive horizontal layers of loose material not more than [_____] mm inches in depth. Pieces of rock larger than [_____] mm inches in greatest dimension shall not be used. Each

layer of material shall be spread uniformly, completely saturated, and compacted [to a minimum density of [_____] kg/cubic m pcf] [until the interstices are filled with well-compacted materials and the entire layer is a densely compacted mass]. Each successive layer of material shall adequately bond to the material on which it is placed. Compaction shall be accomplished with vibratory compactors weighing at least [_____] metric tons tons, heavy rubber-tired rollers weighing at least [_____] tons, or steel-wheeled rollers weighing at least [_____] metric tons tons. In embankments on which pavements are to be constructed, rock shall not be used above a point [_____] mm inches below the surface of the pavement.

3.9 SUBGRADE PREPARATION

3.9.1 Construction

NOTE: Moisture content limits for compaction should be included in these paragraphs when considered necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when in the opinion of the project geotechnical engineer, moisture control is required for the soils being used.

Special smoothness tolerances are not required for subgrades for railroads; therefore, the sentences in brackets will be removed when preparing specifications for preparation of railroad subgrade only. When preparing specifications for preparation of roadway and/or airfield pavement subgrade, the brackets will be removed from the applicable sentences and the smoothness tolerances, showing permissible deviations in fractions of an inch and the length of straightedge in feet, will be inserted in the blanks as appropriate.

Subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 150 mm 6 inches below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. [After rolling, the surface of the subgrade for roadways shall not show deviation greater than [_____] mm inch when tested with a [_____] -mfoot straightedge applied both parallel and at right angles to the centerline of the area.] [After rolling, the surface of the subgrade for airfields shall not show deviations greater than [_____] mm inch when tested with a [_____] -mfoot straightedge applied both parallel and at right angles to the centerline of the area.] The elevation of the finished subgrade shall not vary more than 15 mm 0.05 foot from the established grade and cross section.

3.9.2 Compaction

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the type of material being compacted.

Subgrade for pavements and shoulders shall be compacted to at least 90 percent laboratory maximum density when ASTM D 1557 procedure is applicable or 95 percent laboratory maximum density when ASTM D 4253 procedure is applicable. Laboratory maximum density shall be determined in accordance with requirements in Part 1 above for the depth below the surface of the pavement shown.

3.10 SHOULDER CONSTRUCTION

NOTE: Shoulder construction will form a part of the work to be performed under this section of the specifications except when shoulder construction is specified under the subbase, base-course, wearing course, or pavement sections of the specifications and is designated in the contract to be performed and paid for under one of these sections.

Shoulders shall be constructed of satisfactory excavated or borrow materials or as otherwise shown or specified herein. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission of the Contracting Officer has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above [, for specific ranges of depth below the surface of the shoulder]. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment well suited to the type of material being compacted. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section shown.

3.11 FINISHING

The surface of all excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for all graded areas shall be within 30 mm 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades shall be specified in paragraph SUBGRADE PREPARATION above. Gutters and ditches shall be finished in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

3.12 TESTING

NOTE: Density tests other than those specified in this paragraph may be required for certain types of soil, in which case the reference to ASTM D 1557, will be deleted and the laboratory compaction requirement applicable to the soil encountered will be specified. See DM 21.3/TM 5-825-2/ AFM 88-6, Chap. 2, for a discussion of conditions requiring nonstandard compaction control tests.

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Moisture contents shall be determined in accordance with ASTM D 4643 and/or ASTM D 2216. If the ASTM D 4643 procedure is used, moisture contents shall be checked by the ASTM D 2216 procedure once per each 10 ASTM D 4643 tests. Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. If ASTM D 2922 is used, in-place densities shall be checked by the ASTM D 1556 procedure at a frequency on one sand cone test for each 8 nuclear density tests and not less than one sand cone density test per lift. The sand cone test shall be performed adjacent to the location where a nuclear density test was performed to insure a proper correlation is established between the two density test procedures. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements, at no additional expense to the Government. Tests on recompacted areas shall be performed to determine conformance with specification requirements. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

3.12.1 Moisture Content

Moisture contents shall be determined on materials obtained from each density sample location.

3.12.2 Optimum Moisture and Laboratory Maximum Dry Density

The laboratory maximum dry density shall be determined from materials obtained at a sand cone test location using the appropriate procedure specified in Part 1 above. When ASTM D 1557 is used, the optimum moisture content shall be determined. A minimum of one laboratory maximum dry density test shall be run each placement day or fraction thereof. Additional laboratory maximum dry density tests shall be run for each material change.

3.12.3 Fill and Backfill Material Gradation, Liquid Limit, and Plastic Limit

A minimum of one gradation, liquid limit, and plastic limit test shall be run per 2,000 cubic yards of material placed. The tests shall be run on material used to determine the laboratory maximum dry density. Gradation of fill and backfill material shall be determined in accordance with ASTM D 422. Liquid limit and plastic limit shall be determined in accordance with ASTM D 4318.

3.12.4 In-Place Densities

- a. One test per [700] [] square meters [7,500][] square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.
- b. One test per [23] [] square meters [250] [] square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.
- c. One test per [30] [] linear meters [100] [] linear feet, or fraction thereof, of each lift of embankment or backfill for roads.
- d. One test per [] linear meters feet, or fraction thereof, of each lift of embankment or backfill for railroads.

3.12.5 Tolerance Tests for Subgrades

Continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION shall be made during construction of the subgrades.

3.13 SUBGRADE AND EMBANKMENT PROTECTION

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished subgrade will not be permitted. No subbase, base course, ballast, or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

ADDITIONAL NOTES

NOTE A: For additional information on the use of all
CEGS, see CGES-01000 CGES GENERAL NOTES.

NOTE B: This specification includes materials,
construction, and testing requirements for excavation,
embankment, and preparation of subgrades.
